Lighthouse Delta 2013

24 - 29 November, KIAMA, Australia

Shining through the fog

The 9th Delta Conference of teaching and learning of undergraduate mathematics and statistics

Conference Program & Abstracts
Shining through the fog

The 9th Delta Conference on teaching and learning of undergraduate mathematics and statistics
24 - 29 November, KIAMA, Australia

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Welcome to **Lighthouse Delta**!

We are pleased to have our DELTA friends back in Australia! This 9th Delta Conference on Teaching and Learning of Undergraduate Mathematics and Statistics has delegates and guests from fourteen countries and from all continents except Antarctica.

We have an exciting academic program, thought provoking keynote and invited speakers, and a magnificent venue to foster networking and collaborations. Under the conference theme *Shining through the fog* the program covers a wide range of challenges faced by those responsible for providing mathematics education within the higher education sector, including:

- Curriculum renewal to adapt to the changing needs of our graduates
- Teaching and learning standards related to mathematics and statistics
- Assessment practices
- Teaching mathematics and statistics to non-mathematicians
- The changing students expectations
- Innovative teaching and assessment approaches
- Pathways into university level mathematics and statistics
- Use of technology
- Influencing policy.

Following DELTA tradition, the work of our presenters is published in a special issue of the *International Journal of Mathematics Education in Science and Technology* and in peer reviewed *Conference Proceedings* including abstracts and full papers.

We wish you an enjoyable and memorable stay in Kiama!

*The DELTA 2013 Local Organising Committee*

*Cristina Varsavsky (Chair)*
GENERAL INFORMATION

The Venue
The venue for the conference is "The Pavilion" conference centre in Bong Bong Street, Kiama, New South Wales, Australia. The Pavilion conference centre is located approximately 400 metres (5 minute walk) from the Kiama railway station.

Registration Desk
For general enquiries and assistance, please visit the Registration Desk at any time.

Disclaimer
Whilst we have endeavoured to ensure all information is accurate, the organisers reserve the right to change any aspect of the program without prior notice.

Messages
A message board will be located near the Registration Desk. Messages can be left with the organising staff at the registration desk.

Name Badges
Please ensure that you wear your conference name badge at all times during the conference sessions and social functions.

Photocopying at the Conference
There are no photocopying facilities at the conference venue, so please ensure you bring a sufficient number of any handouts.

Free Wi-Fi Access
Wireless Internet is available in all the conference venues. The access code is available at the Registration Desk.

Privacy
Conference Connections will gather and record personal information necessary for your attendance at the Conference. Personal information will be gathered, stored and disseminated in accordance with the Australian National Privacy Principles.

Photography
Event photographers will be taking pictures of presenters and delegates during the conference sessions and social events. We recommend you advise the photographers if you do not wish to be included in photographs.

Speaker Support
Speakers should ensure that their presentation is loaded into the system and tested before their session. Technical assistance is available through the Registration Desk.

Social program

Welcome reception
Sunday 24 Nov, at The Norfolk Room, 7pm till late. Dress code is “casual”.

Conference Dinner
Thursday 28 Nov, at The Norfolk Room, 7:30pm till late. Dress code is “smart casual”. With great food and atmosphere, this will be a perfect opportunity to relax and dance the night away.
Conference Excursions

Wednesday 27 Nov is Excursion Day. The following three activities come highly recommended by the local organising committee:

- **Segway Tours**
- **Illawarra Fly Treetop Walk**

Information about other ‘see-and-do’ activities in and around Kiama may be found at the Kiama Tourist Information website http://www.kiama.com.au/see-and-do.

Please note: DELTA delegates must make their own way to and from any activity. All associated costs are also at the delegates’ expense.

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Organising Committee

Cristina Varsavsky (Monash University),
Shaun Belward (James Cook University),
Deborah King (University of Melbourne),
Dann Mallet (Queensland University of Technology),
Leanne Rylands (University of Western Sydney),
Carmel Coady (University of Western Sydney),
Birgit Loch (Swinburne University of Technology),
Kelly Matthews (University of Queensland),
Mark Nelson (University of Wollongong).

International Steering Committee

Tracy Craig (South Africa)
Johann Engelbrecht (South Africa)
John Hannah (New Zealand),
Ansie Harding (South Africa),
Joel Hillel (Canada),
David Holgate (South Africa),
Harvey Keynes (USA),
Victor Luaces (Uruguay),
Aisling Mccluskey (Ireland),
Greg Oates (New Zealand),
Ivan Reilly (New Zealand),
Cristina Varsavsky (Australia),
Leigh Wood (Australia).
Conference Program
### SUNDAY 24

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<td>7.00</td>
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### MONDAY 25

#### 8.45 – 9.00
**The Norfolk Room**

**WELCOME TO LIGHTHOUSE DELTA**
Cristina Varsavsky

#### 9.00 – 10.00
**The Norfolk Room**

**KEYNOTE:** Sandra Laursen, *From innovation to implementation: Multi-institution pedagogical reform in undergraduate mathematics* [P]
Chair: Kelly Matthews

#### 10.00 – 10.30

**MORNING TEA**

#### 10.30 – 12.30

**MULTIPLE STREAM SESSION 1**

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<td>10.30 – 10.55</td>
<td>The role of First Year Coordinators of mathematics programs [A]</td>
<td>Deborah King</td>
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<td>10.30 – 10.55</td>
<td>The statistical anxiety rating scale: A review and a new application [A]</td>
<td>Lyndon Walker</td>
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<td>10.30 – 10.55</td>
<td>A longitudinal study of students undertaking a mathematics major: Changes in attitudes, learning behaviours and achievement [A]</td>
<td>Susan Worsley</td>
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<td>11.00 – 11.25</td>
<td>Summer school versus term-time for fundamental mathematics at the tertiary level [A]</td>
<td>David Easdown, George Papadopoulos and Collin Zheng</td>
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<td>11.00 – 11.25</td>
<td>Do highly mathematics-anxious students fear mathematics or the thought of attempting a mathematics question? [A]</td>
<td>Anne D’Arcy Warmington</td>
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<tr>
<td>11.30 – 11.55</td>
<td>How should we treat repeating students? [A]</td>
<td>Student confidence in mathematics – pre- and post-support [A]</td>
<td>John Hannah and Alex James</td>
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<td>Lesley Wilkins</td>
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<td>Bill Blyth</td>
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<td>12.00 – 12.25</td>
<td>‘I’m worried about the correctness’: undergraduate students as producers of screencasts of mathematical explanations for their peers - lecturer and student perceptions [IJMEST]</td>
<td>‘I’m worried about the correctness’: undergraduate students as producers of screencasts of mathematical explanations for their peers - lecturer and student perceptions [IJMEST]</td>
<td>Tony Croft, Francis Duah and Birgit Loch</td>
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<td>12.30 – 2.00</td>
<td>LUNCH</td>
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<td>2.00 – 2.25</td>
<td>Engineering mathematics</td>
<td>Motivating students in an introductory matrix algebra course [A]</td>
<td>Learning mathematics</td>
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<td>Facilitator: David Jeffrey</td>
<td>Karsten Schmidt</td>
<td>Facilitator: Johann Engelbrecht</td>
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<td>2.30 – 2.55</td>
<td>Practising engineers’ conceptions about how mathematics should be taught to engineering students [A]</td>
<td>Modified Japanese lesson study for post-secondary mathematics education [A]</td>
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<td></td>
<td>Johann Engelbrecht, Christer Bergsten and Owe Kågesten</td>
<td>Barbara Edwards and Gulden Karakok</td>
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<td></td>
<td>David Jeffrey and Robert Corless</td>
<td>Carmel Coady, Lyn Armstrong, Harkirat Dhindsa, John Nicholls, Jim Pettigrew and Don Shearman</td>
<td>Batseba Mofolo-Mbokane, Johann Engelbrecht and Ansie Harding</td>
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<td>3.30 – 4.00</td>
<td>AFTERNOON TEA</td>
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<td>Time</td>
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<td>4.00 - 4.25</td>
<td>The significance of designing a course in mathematics focusing on fundamental mathematical concepts [A] Sho Niitsuma and Ryosuke Nagaoka</td>
<td>Tracy Craig, Kendall Room</td>
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<td>Prior decisions and experiences about mathematics of students in bridging courses [IJMEST] Sue Gordon and Jackie Nicholas</td>
<td>Carmel Coady, Surf Beach</td>
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<td>Study process for mathematics: Disjointed or embedded? [A] Maritz Snyders and Sarie Snyders</td>
<td>Alice Richardson, The Norfolk Room</td>
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<td>4.30 - 4.55</td>
<td>Conceptions of mathematics and student identity: Implications for engineering education [IJMEST] Tracy S. Craig</td>
<td>Shigeto Yuito and Ryosuke Nagaoka</td>
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<td>On an “essential” difficulty in bridging the gap between school and university mathematics [A] Alice M Richardson, Peter K Dunn and Rene Hutchins</td>
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<td>5.00 - 5.25</td>
<td>The role of modeling mathematics teaching in improving mathematical teaching skills for student teachers [A] Talal Al-Harbi</td>
<td>David Smith and Lawrence Moore</td>
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<td>An interactive online calculus text for the iPad (and other browsers) [A] David Smith and Lawrence Moore</td>
<td>Ayse Bilgin, David Bulger and Greg Robertson</td>
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<td>9.00 – 10.00</td>
<td><strong>KEYNOTE:</strong> John Rice, <em>Calculus unlimited</em> [A]</td>
<td>The Norfolk</td>
<td>Carmel Coady</td>
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<td><strong>Chair:</strong></td>
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<td>10.00 – 10.30</td>
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<td>10.30 – 11.30</td>
<td><strong>PLENARY:</strong> Peter Bier, <em>The mathematics of juggling</em> [A]</td>
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<td><strong>MULTIPLE STREAM SESSION 4: Assessment</strong></td>
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<td><strong>Facilitator:</strong> Judy Paterson</td>
<td>Kendall Room</td>
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<td>Efficacy and efficiency in formative assessment: An informed reflection on the value of partial marking [IJMEST] Katherine A. Seaton</td>
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<td><strong>Facilitator:</strong> Carol Robinson</td>
<td>Surf Beach</td>
<td>Development of a summated scale for measuring approaches to assessment practice of undergraduate mathematics lecturers [A] Sven Trenholm, Carol Robinson, and Lara Alcock</td>
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<td><strong>Facilitator:</strong> Cristina Varsavsky</td>
<td>The Norfolk</td>
<td>Assessing students using multi-choice tests and exams: How to examine skills, processes and in-depth mathematical understanding [A] Julia Novak and Tanya Evans</td>
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<td>11.30 – 11.55</td>
<td><strong>Efficacy and efficiency in formative assessment:</strong></td>
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<td><em>Katherine A. Seaton</em></td>
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<td>12.00 – 12.25</td>
<td><strong>Undergraduate mathematics outcomes:</strong></td>
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<td>Curriculum design, assessment and technology in mathematics for biomedical sciences: A case study [A] Steven Carnie and Anthony Morphett</td>
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<td><em>Judy Paterson and Bill Barton</em></td>
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<td>Undergraduate mathematics and statistics assessment practices in Australia [P] Cristina Varsavsky, Karen Hogeboom, Carmel Coady and Deborah King</td>
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<td>12.30 – 1.30</td>
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<td>12.30 – 1.00</td>
<td><strong>POSTERS – The Pavilion foyer</strong></td>
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<td>1.30 – 3.30</td>
<td><strong>SPOTLIGHT ON MATHEMATICS ASSESSMENT</strong></td>
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<td>1.30–1.40</td>
<td>Cristina Varsavsky - Introduction</td>
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<td><strong>Invited speaker:</strong> David Boud, Changing assessment: Shifting the emphasis to learning and use</td>
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<td><strong>Invited speaker:</strong> Adrian Simpson, Views of mathematics assessment in the UK</td>
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<td><strong>SPOTLIGHT ON MATHEMATICS ASSESSMENT CONTINUED</strong></td>
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<td><strong>Panellists:</strong> David Boud, Carmel Coady, Karen Hogeboom, Deborah King, and Adrian Simpson</td>
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<td>9.00 – 10.00</td>
<td><strong>KEYNOTE:</strong> Marcelo C. Borba, <em>The changing notion of a mathematics problem in the internet age</em></td>
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<td>10.30 – 11.30</td>
<td><strong>PLENARY</strong> Leanne Rylands, <em>Mathematics and ocean swimming</em></td>
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<td>11.30 – 12.30</td>
<td><strong>MULTIPLE STREAM SESSION 5</strong></td>
<td>Kendall Room</td>
<td>Kelly Matthews, Shahab Abdulla, Kerri Spooner</td>
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<td><strong>Quantitative skills</strong></td>
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<td>11.30 – 11.55</td>
<td>Teaching first-year business statistics three ways</td>
<td>Kendall Room</td>
<td>R. Nazim Khan</td>
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<td><strong>Students’ preparation</strong></td>
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<td>12.00 – 12.25</td>
<td>Mathematics and statistics for life science students: Discussing the contribution of mathematics and statistics departments</td>
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<td>Cristina Varsavsky and Kelly Matthews</td>
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<td><strong>LUNCHTIME MAPLE Workshop</strong></td>
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<td>Facilitator: Miranda Mortlock</td>
<td>Facilitator: Pragashni Padayachee</td>
<td>Facilitator: Gulden Karakok</td>
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<td>2.00 – 2.25</td>
<td>Use and perceptions of worked example videos for first-year students studying mathematics in a primary education degree [P]</td>
<td>Simon James, Jacqui Brown, Toni Gilbee and Chloe Rees</td>
<td>Differential equations and handheld CAS technology [A]</td>
<td>Greg Oates, Louise Sheryn and Mike Thomas</td>
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<td>Patrick Tobin and Vida Weiss</td>
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<td>Assignment submission via video in a large first year calculus class [A]</td>
<td>David Holgate, Justin Munyakazi, Leila Adams and Duncan Smith</td>
<td>First year university students’ understanding of functions. Over a decade after the introduction of CAS in Australian high schools, what is new? [P]</td>
<td>Caroline Bardini, Robyn Pierce and Jill Vincent</td>
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<td>Carolinakok, Nicole Angelke and Aaron Wangberg</td>
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<td>Pragashni Padayachee</td>
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<td>3.30 – 4.00</td>
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<td><strong>Feedback</strong>&lt;br&gt;Facilitator: Leanne Rylands&lt;br&gt;Kendall Room</td>
<td><strong>Miscellaneous</strong>&lt;br&gt;Facilitator: Leigh Wood&lt;br&gt;Surf Beach</td>
<td><strong>Topics in tertiary mathematics</strong>&lt;br&gt;Facilitator: Ilya Shilin&lt;br&gt;The Norfolk Room</td>
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<td>5.00 – 5.25</td>
<td>Mathematics exams as a learning process to build skills, knowledge and confidence [A]&lt;br&gt;Carolyn E. Sandison and Carole L. Birrell</td>
<td>An elementary statistical workshop course for postgraduate research students [A]&lt;br&gt;Ant Edwards and Chris Mellor</td>
<td>Introducing queuing theory through simulations [P]&lt;br&gt;Wan Mei Soon and Keng Cheng Ang</td>
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7.30 – late **CONFERENCE DINNER - The Norfolk Room at The Pavilion**
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| 9.00 – 10.00 | The Norfolk Room | **KEYNOTE:** Merrilyn Goos, Knowledge for teaching secondary school mathematics: What counts? [IJMEST]  
**Chair:** Shaun Belward |                                                                                     |
| 10.00 – 10.30 |                  | **MORNING TEA**                                                               |                                                                                     |
| 10.30 – 12.30 | Kendall Room     | **MULTIPLE STREAM SESSION 8**                                                 |                                                                                     |
| 10.30 – 11.55 | Kendall Room     | Technology                                                                     | Facilitator: Jeff Waldock                                                           |
|            |                  | StatsCasts: Supporting student learning of introductory statistics [P]         | Christine McDonald, Peter K. Dunn, Birgit Loch and Vida Weiss                        |
| 11.00 – 11.25 | Surf Beach       | Theory and research                                                            | Facilitator: Jenny Henderson                                                        |
| 11.30 – 11.55 | Surf Beach       | The future of mathematics teaching                                            | Facilitator: Dilshara Hill                                                         |
|            |                  | Developing prospective mathematics teachers in Mexico: a lesson on the relationship between integration and differentiation [IJMEST] | Dilshara Hill and Carolyn Kennett                                                   |
| 11.30 – 12.30 | Surf Beach       | Using a classroom response system to transform student engagement [A]          | Raymond Summit and Tony Rickards                                                   |
| 12.00 – 12.25 | Surf Beach       | Effectiveness of online lectures in a first year mathematics unit [A]         | Carolyn Kennett and Dilshara Hill                                                  |
| 12.30 – 2.00  |                  | **CLOSING CEREMONY and LUNCH**                                                |                                                                                     |
Abstracts for Oral Presentations
Sandra Laursen is co-director of Ethnography & Evaluation Research (E&ER), an independent research unit at the University of Colorado Boulder that studies higher education and career development in science, engineering and mathematics (www.colorado.edu/eer). Her research interests include underrepresentation of women and people of color in the sciences, inquiry-based teaching and learning, and organizational change in higher education. Laursen has published chemistry curriculum manuals and journal articles in chemistry, education, gender studies, and the Journal of Irreproducible Results, co-directed a documentary film, and recorded a CD with Resonance Women’s Chorus. She earned a Ph.D. in chemistry from the University of California at Berkeley.

From innovation to implementation: Multi-institution pedagogical reform in undergraduate mathematics

The use of student-centred teaching approaches improves student learning and persistence in undergraduate science, engineering and mathematics, but most prior studies have investigated these reforms on small scales and in well-understood conditions. A study of inquiry-based learning (IBL) as applied in undergraduate mathematics at four U.S. research universities demonstrates that such reforms are effective when applied on a multi-course, multi-institution scale that can make a real impact on student outcomes. Here we highlight three key points relevant to research and practice. First, despite variation in the nature and quality of IBL implementation across some 40 courses and 100 course sections studied, positive student outcomes are detected relative to traditionally taught courses. The use of IBL methods benefits women, first-year and initially lower-achieving students in particular ways. Second, the research design appropriate for such studies will necessarily differ from those possible in single courses, requiring general measures that can be used with multiple courses and audiences. Finally, sizable investment in course-specific reforms does not assure that they will remain in place, but professional development of early-career instructors is a powerful by-product that spreads the method to new courses and institutions and thus helps to broaden faculty use of research-based reforms.
The role of first year coordinators of mathematics programs

DEBORAH KING
University of Melbourne, Australia

Keywords: First year; transition; mathematics

In this talk we discuss our progress on the OLT funded project Building Leadership Capacity in University First Year Learning and Teaching in the Mathematical Sciences, which seeks to build a vibrant national network of scholars who provide leadership in first year learning and teaching in the mathematical sciences. In addition, it aims to examine and promote the unique leadership role of first year coordinators and educators.

We have now interviewed sixteen academics who have a significant role in first year mathematics teaching. We asked these academics what their responsibilities are in relation to curriculum design, administration, student support, student learning and transition activities.

In addition, for those with designated leadership roles, we asked how they and others viewed their role, why did they want to hold such a position, did they have a high level of job satisfaction, and did they see that there was a career pathway for them once they had left their position.

In our June workshop, around 40 academics gathered to discuss the main challenges of their roles as mathematics educators. Student preparedness, diversity of incoming students, student engagement and high academic workloads were common examples given.

We give a brief report of these findings.

The statistical anxiety rating scale: a review and a new application

LYNDON WALKER
Swinburne University of Technology, Australia

Keywords: Statistics anxiety; student demographics; first year teaching

The Statistical Anxiety Rating Scale (STARS) is a 51 item, 5 point Likert scale developed by Cruise and Wilkins in 1980 to measure levels of statistics anxiety in students. Despite its age, and some American-centric and out of date items, the STARS is still commonly used as a measure of student attitudes towards statistics. In this presentation I will cover three aspects of the scale, and some experiences with administering it to a cohort of first year online students. Firstly, I will examine the relevance of the scale to 21st century statistics education and discuss whether collecting such information is useful for statistics educators. Secondly, I will discuss some STARS results from a sample of Australian students completing an online first year statistics unit. Finally, I will present an example of where the STARS was administered to students, but it inadvertently became a useful teaching example and created some insightful, student-lead discussions about bias and data collection.
Factors influencing student decision on senior secondary school subjects

MICHAEL JENNINGS
The University of Queensland, Australia

Keywords: Transition; first-year; attitudes

There are substantial and ongoing concerns in the Australian and international secondary and tertiary education sectors about students’ transition from secondary to tertiary mathematics. Declining enrolments in university mathematics and increasing failure rates in first year are often attributed to falling participation in advanced mathematics in secondary school and less stringent university entry requirements, which have adversely affected students' mathematical preparedness for university study.

In this presentation I will present data collected on three topics: reasons for choosing/not choosing advanced mathematics in secondary school, attitudes towards learning mathematics at school, and attitudes towards learning mathematics at university. This data was collected from four separate groups of people: secondary school mathematics students, secondary school mathematics teachers, university mathematics academics, and university mathematics education academics. The results suggest that there are distinct differences in students’ thoughts depending on which mathematics they study in the last two years of secondary school. There are also differences between what students say are the reasons for their subject choice and what mathematics academics think are the reasons. The data also sheds light on subject choice myths. This presentation is part of a two-year state-wide longitudinal project that is investigating the transition from secondary to tertiary mathematics.

Summer school versus term-time for fundamental mathematics at the tertiary level

DAVID EASDOWN, GEORGE PAPADOPOULOS AND COLLIN ZHENG
University of Sydney, Australia

Keywords: Summer school versus term-time; fundamental first year mathematics; students with learning difficulties

At the University of Sydney, there exists evidence that students undertaking first year mathematics units achieve superior teaching and learning outcomes and experience higher overall course satisfaction by completing these units at Summer School rather than during standard term-time. We discuss relevant issues, with far-reaching implications for intensive, short-duration type teaching and learning in general, and with the particular aim of improving teaching practices and quality of learning during term-time. This is especially important due to the mandatory nature of first year mathematics for Science degrees at the University of Sydney, which becomes problematic for students with an inadequate background in mathematics from high school, with learning difficulties or phobias, or returning to study after long absences. Many such students enrol into Fundamental Level units, which form the focus of this research. We make qualitative observations about students' relative rates of progress and development of mathematical skills and maturity, inspect quantitative data about relative performances in term-time and in Summer School, discuss possible reasons for the differences, and attempt to place the findings within the contexts of modern theories of learning, such as the theory of threshold concepts, constructive alignment and the SOLO taxonomy.
Do highly mathematics-anxious students fear mathematics or the thought of attempting a mathematics question?

ANNE D'ARCY-WARMINGTON
Curtin University, Australia

Keywords: Mathematics anxiety; brain activity; tertiary mathematics

Commonly heard phrases in any mathematics class to students are ‘use your brain’ or ‘just have a go, write something’. What if the brain reacts to hinder the mathematical thought process before it even has a chance to start? Do students fear the thought of attempting a mathematics question more than the actual mathematics itself? It could be this fear that prevents students from obtaining a better grade in tests rather than lack of mathematical knowledge.

The work of Beilock and Lyons (2011) investigated how the brain reacted to knowing a mathematical rather than word question was to be asked. The highly mathematics-anxious students who did not activate the associated part of the brain proceeded to answer only 68% of the questions correctly. So the answer to helping highly mathematics-anxious students may be utilising this control of fear rather than extra exercises. This presentation will discuss simple activities that may aid our weaker students to improve their score, recognise and control their fear and decrease mathematical anxiety.

A longitudinal study of students undertaking a mathematics major: Changes in attitudes, learning behaviours and achievement

SUSAN WORSLEY
University of Queensland, Australia

Keywords: Mathematics education; higher education; attitudes; learning behaviours; achievement; longitudinal study

How do a student’s attitudes, learning behaviours and achievement in mathematics or statistics inter-relate with each other and how do these change during the course of their undergraduate degree program? In this talk I report on a longitudinal study of students through the three years of a mathematics degree. The two questions I investigated were “What are students’ attitudes and learning behaviours towards mathematics and to what extent do these attitudes and learning behaviours change as students’ progress in mathematics?” and “Are these attitudes and learning behaviours related to achievement?” Students were surveyed after each semester on a maximum of two mathematics or statistics courses they had taken. Responses from a small group of 21 students who had completed both first and third level course surveys are discussed in this talk as are the attitudes and learning behaviours that have changed over this period.
How should we treat repeating students?

JOHN HANNAH AND ALEX JAMES
University of Canterbury, New Zealand

Keywords: Repeating students; engineering mathematics; transferable skills

Usually repeating students simply join the next occurrence of the failed course. They attend lectures and read handouts which assume they have never seen the material before. Often they are set the same homework, tutorial exercises and assignments that they were supposed to do the first time round. Unfortunately, by repeating the entire course experience like this, such students often drift towards a repeat of the failure too. This talk looks at a small group of students repeating a first-year engineering mathematics course. For political reasons, rather than educational ones, the repeat version of the course was restricted to students who had failed the course in the previous semester. But educationally, this meant that the course could be tailored to their common background. Thus the lecturer could take advantage of their prior experience of the course content while at the same time focusing attention on generic and transferable skills, such as time management, study habits and applying mathematical ideas in new contexts. All the students passed the repeated course, and the lessons learned seem to have persisted since, as a group, they have performed significantly better in their second year mathematics course than might have otherwise been expected.

Student confidence in mathematics – pre- and post-support

LESLEY WILKINS
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Keywords: Mathematics confidence; mathematics support; success

Learning Development university lecturers are charged with supporting students who find mathematics “challenging” but who need to study mathematics – and pass it – as part of the requirements of their non-specialist-mathematics courses. In order to measure both the success of the students who seek assistance through Learning Development and the possible effects of the support, the students’ levels of confidence in mathematics were studied, comparing their confidence pre- and post-support. Students’ mathematics confidence was studied in two different aspects: firstly, their levels of confidence in mathematics overall and secondly, their levels of confidence in the various topics for which they were seeking support through Learning Development. Did their level of confidence in a topic change after a support session and, perhaps more importantly, did their overall level of confidence in mathematics change over a period of support?
Letters and numbers: A vehicle to illustrate mathematical and computing fundamentals

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² Bond University, Australia

Keywords: Letters and numbers; mathematics; computer science

The television quiz program Letters and Numbers, broadcast on the SBS network, has recently become quite popular in Australia. This paper explores the potential of this game to illustrate and engage student interest in a range of fundamental concepts of computer science and mathematics. The Numbers Game in particular has a rich mathematical structure whose analysis and solution involves concepts of counting and problem size, discrete (tree) structures, language theory, recurrences, computational complexity, and even advanced memory management. This paper presents an analysis of these games and their teaching applications, and presents some initial results of use in student assignments.

Mathematics bridging courses and success in first year calculus

LEON POLADIAN AND JACKIE NICHOLAS
The University of Sydney, Australia

Keywords: Mathematics bridging courses; calculus; student preparedness

Students entering university with insufficient mathematics preparation for the courses they intend to study is an increasing problem. We show evidence of how withdrawal rates, failure rates, and final marks in a first year calculus unit are strongly associated with the level of mathematics studied at school, the assumed knowledge published for the degree and enrolment in a bridging course. Bridging course students were, on the whole, able to pass their first semester university calculus-based subject; however, they did not achieve at the level of their mathematically well-prepared peers.
Maximum problems without calculus: Design, teaching and assessment using Maple

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Australian Scientific & Engineering Solutions (ASES) and RMIT University, Australia

Keywords: Computer algebra system, maple, visualization, parameterized assignments, computer aided assessment

At RMIT University, weekly computer laboratory sessions using Maple have been a component of an otherwise traditional first year calculus course at university. The Maple topics come from the senior school curriculum, but with innovative approaches to curriculum, pedagogy and assessment. A major objective is that students have a positive attitude to using Maple. Some of first year calculus repeats senior school calculus: including “Word problems” which have always been difficult for students. This paper focuses on Maximum problems. Our Maple topics have no lectures: students work collaboratively in small groups, and we take full advantage of the visualizations afforded by the Computer Algebra System (CAS). Students follow an explicit Polya approach to a maximizing an area problem, with an assignment on the Norman window problem that's individualized for each student group. We also introduced multiple representations and multiple solution methods: graphical (zoom-in), animation, proof without calculus and with calculus; with an accompanying parameterized assignment. Here we re-design some optimization problems where the maximum can be found without calculus. If the objective function is a quadratic polynomial, all that is needed is properties of quadratics. Whilst not quite so obvious, for cubic polynomials we show how to find the maximum (and use CAS for scaffolding: to handle some algebraic manipulation). Problems are parameterized so student groups see “different” problems and we use Computer Aided Assessment, CAA (within Maple or using MapleTA) to automatically assess these parameterized assignments. Surveys show students really like immediate automatic marking. Students are engaged, active and collaborative learners with these Maple sessions.

‘I’m worried about the correctness’ – Undergraduate students as producers of mathematics screencasts – lecturer and student perceptions

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Abstract published in IJMEST journal.
Dealing with engagement issues in engineering Mathematics

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Keywords: Engineering mathematics; engagement issues; assessment; tutorials

Engineering Mathematics is a core second year level subject for students majoring in all branches of engineering at the University of Melbourne. The subject has been taught three times a year since 2009. From the outset, teaching staff had difficulty engaging the students in Engineering Mathematics. Every semester, there were issues with poor lecture and tutorial attendance, substandard performance on continual assessment and on the final exam, and poor pass rates. To deal with these engagement and performance issues, in 2013, teaching staff introduced a hurdle on continual assessment and changed the format of tutorials. In this talk, I will discuss the challenges faced, the changes made to assessment and tutorials, and the effect of the changes on student engagement and performance in assessment.

Motivating students in an introductory matrix algebra course

KARSTEN SCHMIDT
Schmalkalden University of Applied Sciences, Germany

Keywords: Matrix algebra; magic square; eigenvalue; inverse

Linear algebra is certainly an area of mathematics of increasing importance. Unfortunately, most business and economics students do not appreciate courses in mathematics and statistics. This is particularly true for the (introductory) matrix algebra course because most topics are rather abstract and easy-to-apply examples are difficult to find.

However, magic squares can be very helpful in stimulating students’ interest in matrix algebra and are easy to apply. A magic square of order n is a square arrangement of n² real numbers, such that the sum of the elements in each row, column, and diagonal is equal to a constant s, its magic sum.

Many interesting activities can be carried out in class at very different stages of the course, using a Computer Algebra System to facilitate computations.

Any 3x3 magic square M can be written as the sum of two matrices, M = sG + N, where G = 1/3J (J denotes the matrix of ones), and also N has a simple structure defined by only two real numbers. This allows additional interesting activities.

Magic squares from different times and regions, like the ancient Chinese 3x3 Lo-Shu (4,9,2;3,5,7;8,1,6), will be used as examples in the presentation.
A mathematics support program for first-year engineering students

POH WAH HILLOCK, MICHAEL JENNINGS, ANTHONY ROBERTS AND VICTOR SCHARASCHKIN

Abstract published in IJMEST journal.

Practising engineers’ conceptions about how mathematics should be taught to engineering students

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¹University of Pretoria, South Africa
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Keywords: Engineering students; procedural mathematics; conceptual mathematics

Demands from engineering faculties to mathematics departments have traditionally mainly been for teaching computational mathematical skills to engineering students. At the same time high expectations exist in terms of analytic and creative knowledge based skills for engineers as a work force. We report from a collaboration project between South Africa and Sweden with the aim to investigate whether the emphasis in undergraduate mathematics courses for engineering students would benefit from being more conceptually oriented than the traditional more procedurally oriented way of teaching. In this presentation we report on conceptions of practicing engineers about this issue.
Modified Japanese lesson study for post-secondary mathematics education

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**Keywords:** Pre-calculus courses; lesson study; curriculum development

For several years Japanese educators have engaged in a method known as *lesson study* to develop elementary curriculum. *Lesson study* is a practice in which teachers consider long term goals of education, determine the goals of their particular subject area, plan specific lessons and then systematically study the impact of these lessons through classroom testing. Although *lesson study* has appeared almost exclusively among teachers at the elementary level of education – and most educational research comes from this level – there is evidence that this practice can be applied at the post-secondary educational level. In this presentation we will share our experience of implementing *modified lesson study* at the college level. We will discuss how we implemented these practices to develop mathematics lessons that would address a lack of student success in a multi-section course (College Algebra) infamous in the United States for its high failure rate. Indeed, the difficulties students encounter in this course have been acknowledged as one of the leading causes of student drop-out at the post-secondary level. In our presentation we will demonstrate our *modified lesson study* framework by discussing *Blood Alcohol Level*, a lesson designed as an introduction to the concept of mathematical function and their models.

Inverse modelling problems in linear algebra undergraduate courses

VICTOR MARTINEZ-LAUCES

Abstract published in IJMEST journal.
Linear algebra for engineering: Using rectangular systems

DAVID J. JEFFREY AND ROBERT M. CORLESS

Western University, Canada

Keywords: Gaussian elimination; engineering linear algebra; computer algebra

This presentation addresses two themes. The first theme is the giving of greater emphasis to the analysis of rectangular systems when teaching linear algebra. The argument is made that, especially when teaching engineers, for whom the computational aspects of the subject are typically preferred over abstract concepts, there are advantages to the shifted emphasis. The second theme is the teaching of linear algebra with technology, especially with symbolic (computer algebra) systems. The connection between the themes is that the first theme leads inevitably to many questions requiring the row reduction of matrices. This activity is dull and highly error prone, and yet critical to the analysis of problems. Hence, the relegation of row reduction to a computer is desirable.

If a computer-algebra system such as Maple is used for the row-reduction of a matrix, the intermediate steps are not shown. If a matrix contains one or more symbolic elements, there is a danger that the final result will not be valid for all values of the parameter. One solution is to get the computer to return the “Turing factors” of the matrix. Then, in addition to obtaining the desired reduced row-echelon form, the user gets a warning of special cases.

Roving mathematics assistance

CARMEL COADY, LYN ARMSTRONG, HARKIRAT DHINDSA, JOHN NICHOLLS, JIM PETTIGREW AND DON SHEARMAN

University of Western Sydney, Australia

Keywords: Mathematics support; library roving; university students

In recent years, universities have experienced an influx of students enrolling in courses that require a level of mathematical competency which many students lack. Hence these institutions have been under increasing pressure to provide a variety of support mechanisms to assist students, not only with the content of the mathematical units undertaken, but also to bridge any gaps in the assumed mathematical knowledge of students. Students’ interaction with many of these services occurs at times and places dictated by the providers, with the result that many students who require assistance, do not avail themselves of it. With the changing role of the library to a “library commons” and in an attempt to reverse this trend, it was decided to trial a service whereby ”we come to the students”, by way of Library Roving. This presentation will outline the results of the piloting of this type of assistance in a university setting, with preliminary results indicating that students view such support very favourably and that students in all years, from a variety of courses, receive assistance when and where they decide. The staff involved have also been very receptive despite at times, being challenged by the diversity of the questions asked.
Learning difficulties with solids of revolution: Classroom observations

BATSEBA MOFOLO-MBOKANE, JOHANN ENGELBRECHT AND ANSIE HARDING

Abstract published in IJMEST journal.

The significance of designing a course in mathematics focusing on fundamental mathematical concepts

SHO NIITSUMA AND RYOSUKE NAGAOKA
Meiji University, Japan

Keywords: New approach toward modern mathematics; the theory of real numbers; tertiary mathematics education

Very regrettably, most students become discouraged in the earliest stages of fundamental mathematics courses and only do enough to ensure that they pass. Ultimately, some fail to master advanced mathematical concepts. To point out plausible reasons why they fail is easy, but it is of no use to decide which is the most critical. I propose a change in the approach towards tertiary education, specifically within mathematics departments. The most essential point is to not rush the exposition of foundational theories to students. Instead, we should try to pique the students' interest in mathematics by teaching historical, cultural, and philosophical aspects of modern mathematics. By experiencing a deeper understanding of mathematics, young students can become more enthusiastic in learning and become braver to explore a new world of mathematics. In order to achieve this goal, it is believed that university mathematics teachers should refrain from teaching as many mathematical topics as possible and as fast as possible. Instead, they should become prudent, and put some emphasis upon the non-technical value of university mathematics. Not all mathematics lessons should be preparation for further development of “advanced” or “applied” theory.

Prior decisions and experiences about mathematics of students in bridging courses

SUE GORDON AND JACKIE NICHOLAS

Abstract published in IJMEST journal.
Study process for mathematics: Disjointed or embedded?

MARITZ SNYDERS AND SARIE SNYDERS
Nelson Mandela Metropolitan University, South Africa

Keywords: Learning development; embedding skills; study strategies; mathematics teaching

Are our students underprepared or is our institution unprepared for the students that enter higher education? Do students have the necessary skills to cope with the demands of tertiary studies? Are the needed competencies offered in a disjointed or an embedded manner? These are important questions when we consider mathematics pass rates, particularly in South Africa with our huge shortage of qualified teachers. Lecturers are challenged to embed skills development in the classroom and thereby offer students learning development opportunities.

The collaboration between a Student Academic Developer and mathematics lecturer led to integrating study strategies into the mathematics classroom. Students were offered a generic Study Process workshop, the study strategies were then adapted and applied to studying mathematics. Action research methodology was used and students wrote reflective journals on how they studied mathematics in the past and how they study mathematics now. These reflections, together with regular meetings between the researcher, a Student Academic Developer, and the mathematics lecturer resulted in a study process model for Mathematics.

In this presentation the research process that was followed, as well as some of the results, will be shared.

Conceptions of mathematics and student identity: Implications for engineering education

TRACY S. CRAIG

Abstract published in IJMEST journal.
On an “essential” difficulty in bridging the gap between school and university mathematics

SHIGETO YUITO AND RYOSUKE NAGAOKA
Meiji University, Japan

Keywords: The gap between school and university mathematics; elementary geometry in university; traditional or classical geometry

Many authors have pointed out the “gaps” between school and university mathematics and much has been written on this since Klein’s Elementarmathematik vom höheren Standpunkte aus. In the field of geometry we have a serious problem in bridging the gap. In Japan, where there was, and still is, a lot of emphasis on geometry in secondary schools, the scope is limited to poorly systemized elementary geometry (from a logical point of view) and to “common sense” analytic geometry. Meanwhile, in universities, only modern geometry with no active concern for “traditional” or “classical” geometry is taught. As a result, young university students feel much embarrassed with their first encounter with modern geometry and most of them are urged to “memorize” the important theorems and their proofs without any theoretical understanding. When they become school teachers they cannot teach geometry in any depth or with real understanding. I dare to point out the importance of giving lectures on a little old fashioned geometry in universities, especially where not all students are expected to be research mathematicians.

Identification and definition of lexically ambiguous words in statistics by tutors and students

ALICE M RICHARDSON, PETER K DUNN AND RENE HUTCHINS

Abstract published in IJMEST journal.
The role of modeling mathematics teaching in improving mathematical teaching skills for student teachers

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Keywords: Teacher preparation; mathematics instruction; teaching theory; modeling teaching

This qualitative study used action research methodology, in five stages, to discover the effectiveness of a teaching model for teaching basic mathematical teaching skills to students training to be mathematics teachers at the College of Education, Taibah University, Saudi Arabia. In Stage 1, the researcher reviewed studies and research on effective mathematical teaching skills, and constructed a five step model (orientation, concept, generalizing, practice and closure). In Stage 2, 15 student teachers participated in a teaching methods course for seven weeks of intensive professional development. This related to understanding and implementing the five-step model, and exploring practical examples. In Stage 3 the student teachers implemented the model using a collaborative action research approach. The process involved student teachers visiting each other and coding evidence of model implementation. In Stage 4, the student teachers and researcher met again. This time, the participants spent two lectures involved in reflection and learning to preparing their final reflection project. In Stage 5, the student teachers and the researcher held a two-day conference during which they presented their reflections and findings. Student teachers emphasized that the model can be applied to the conventional syllabus, which developed their teaching skills, besides gaining positive attitudes towards teaching.

An interactive online calculus text for the iPad (and other browsers)

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Duke University, United States

Keywords: Differential calculus; integral calculus; interactive text; internet; sage computer algebra system; iPad; standards-compliant browser

The online textbook, Calculus: Modeling and Application, 2nd edition, published by the Mathematical Association of America (MAA), has been adapted for reading and interacting on the iPad. The entire text and its interactions are accessible in any standards-compliant browser (e.g., Firefox, Safari) on any platform. The major changes in this adaptation include replacing XHTML pages with HTML, recasting mathematical symbols in MathJax, and replacing use of commercial computer algebra systems (CAS) with embedded "interacts" that are processed by the open-source CAS Sage. Features of the book will be demonstrated directly from an iPad, and attendees are welcome to use their own iPads, notebooks, or other Internet-capable devices.
Is there a relationship between learning space and satisfaction with learning experience in a first year statistics tutorial class?

AYSE AYSIN BILGIN, DAVID BULGER, GREG ROBERTSON

Macquarie University, Australia

Keywords: Learning space; active and collaborative learning; first year statistics

Over the last decade, from primary schools to higher education institutions, there has been an emphasis on the role of learning spaces in encouraging or debilitating students’ learning experiences. Many new classrooms are built with public funds to create active and collaborative learning spaces which, it has been argued, enable better learning experiences.

Students’ perceived learning experience obtained through a quantitative survey in their last tutorial class in 2012 (n=226) in a large first year statistics unit at Macquarie University supports such claims. We found that active and collaborative learning is significantly correlated with students’ satisfaction in their tutorial classes. Students felt comfortable solving problems after their active and collaborative learning, since they believed that they had a deeper understanding of the concepts. We did not find enough evidence to conclude that the in-class activities had prepared students to tackle the unit’s assessment tasks more effectively or enhanced their critical thinking ability.
John Rice is Executive Director of the Australian Council of Deans of Science (ACDS) and an honorary professor of mathematics at Sydney University. He was the inaugural president of the Council from 1995-1998 and served again as president from 2006-2008. His mathematical interests are in differential and algebraic geometry. As Executive Director of the ACDS from 2008 he established its annual teaching and learning conferences and more recently the ACDS Teaching and Learning Centre. These have created a national forum for teaching and learning leaders in university science and mathematics, and a high profile for the ACDS in teaching and learning policy.

Calculus unlimited

Curriculum reform is a major preoccupation at all levels of education around the world. Science and Mathematics have received particular attention because they are fundamental to 21st century society, they are considered abstract and difficult, and students dislike them, often with a passion. I focus on reform of the calculus curriculum because it is the quintessential example of this problem.

I propose that the calculus curriculum could be improved considerably by avoiding the concept of a limit. I argue that the ideas preceding Newton and Leibnitz, such as expressed in the work of Galileo or Fermat for example, are actually quite precise in their context, more intuitive and develop better the threshold concepts of function, and derivative along with the rules of calculus.

The direct interpretation of infinite decimals, which does not involve limits, provides the threshold understanding of real numbers, integrals and sums of series. This understanding promotes simple numerical methods, particularly the decimation method, into methods for exact solution of equations rather than mere approximations. In fact, the decimation method becomes a proof of the intermediate value theorem. The fundamental theorem of calculus likewise becomes more transparent via the threshold understanding of real numbers and function values.
The mathematics of juggling

PETER BIER
The University of Auckland, New Zealand

Keywords: Mathematics; juggling; workshop; siteswap

A surprising number of mathematicians are jugglers (and vice versa). Upon reflection, the connection is perhaps not quite as odd as it seems. Mathematics is the science of patterns, while juggling is concerned with patterns that can be woven in three dimensions, via manipulation of various objects.

This hands on workshop will introduce you to the art of juggling, as well as the mathematics used to describe and generate new juggling patterns. It will also provide ideas on how you can use juggling to create a more memorable learning experience.

Come along and learn how to juggle three balls.

Threshold concepts in finance: the role of mathematics

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Macquarie University, Australia

Keywords: Threshold concepts; finance; mathematics; curriculum; pedagogy

Threshold concept theory proposes that there are a limited number of transformative concepts that are central to the mastery of any discipline (Meyer & Land, 2003, Cousin, 2006). Research into threshold concepts in finance is limited to the work of Diamond (2011, 2013) and Diamond and Smith (2011) in relation to quantitative finance and business statistics.

We report on a broad project to investigate staff and student perceptions of threshold concepts in finance, with the aim of improving curriculum design and identifying specific pedagogical practices for teaching threshold concepts in order to improve student engagement and outcomes. The particular focus of this part of the project is the investigation of mathematical and statistical threshold concepts in finance programs.

The project combines qualitative and quantitative methods in the collection and analysis of primary data from finance staff and students. Initial findings indicate a degree of ambiguity in relation to the role of mathematics in the finance curriculum. Threshold concepts offer a way to be specific and explicit about the role of mathematics in finance and address this ambiguity.
Development of a summated scale for measuring approaches to assessment practice of undergraduate mathematics lecturers

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**Keywords:** Assessment; deep learning; approaches to teaching; psychometric instrument

Findings associate undergraduate mathematics lecturers with surface and transmissive approaches to teaching. Apart from the recognized dominance of summative instruments, little is known about these lecturers’ approaches to assessment practice.

Early work in undergraduate science education led to the creation of a two-scale Approaches to Teaching Inventory (ATI) that was to be used to explore the relationship between approaches to teaching and other aspects of the teaching-learning environment. For similar purposes, basing our work on Samuelowicz and Bain’s (2002) framework for identifying lecturers’ approaches to assessment practice, we sought to develop a measure (S&B) that quantifies mathematics lecturers’ approaches to assessment practice.

An online survey was created using both the ATI and a newly created S&B questionnaire. Seventy mathematics lecturers responded. Results show that the S&B measure was significantly (p<0.01) correlated, in the expected directions, with both ATI measures. With the ATI as an established psychometric instrument, findings suggest the S&B measure has some validity and is measuring a similar underlying construct. We discuss these findings along with some of the limitations and problems identified by participants.


Assessing students using multi-choice tests and exams: How to examine skills, processes and in-depth mathematical understanding

JULIA NOVAK AND TANYA EVANS

*The University of Auckland, New Zealand*

**Keywords:** Assessment; multi-choice questions (MCQ); learning outcomes; concept maps

Several years ago we decided to move to a MCQ format for tests and exams for our large first year mathematics courses. A major consideration has always been whether we are assessing in ways comparable with long answer pen and paper tests. We will discuss how our questions are created to test a wide range of learning outcomes. The possible use of expert concept maps to inform identification of key outcomes will also be discussed. Our exploration of ways in which a wider spectrum of learning outcomes might be assessed using MCQs forms part of the Learning in Undergraduate Mathematics, Outcomes Spectra Project (LUMOS) funded by Ako Aotearoa (National Centre For Tertiary Teaching Excellence) and TLRI (Teaching & Learning Research Initiative).
Undergraduate mathematics outcomes: The mantis shrimp spectrum

JUDY PATerson AND BILL BARTON
The University of Auckland, New Zealand

Keywords: Undergraduate mathematics; learning outcomes; mathematical behaviours

Undergraduate mathematics worldwide has had more or less standard mathematical content and skills outcomes that have been stable over several decades. But are these outcomes all we really want our students to learn? What other outcomes do we assume will occur, or hope will result, from our programmes? Which of these outcomes do mathematics lecturers regard as most important? Finally, do we have a common view about undergraduate outcomes? Interviewing lecturers in New Zealand and overseas is the first phase of a project to identify all learning outcomes and develop ways to observe whether they occur. We report on the development of a multifaceted “outcome spectrum”, and describe initial interview results, including differences from expectations and differences from what is written in the literature.

Curriculum design, assessment and technology in mathematics for biomedical sciences: a case study

STEVEN CARNIE AND ANTHONY MORPHETT
University of Melbourne, Australia

Keywords: Assessment; biomedical science; curriculum design; technology

We will discuss the principles of student-centred curriculum design, outcome-based assessment design, and the use of interactive technology in the development of a new mathematics subject for undergraduate biomedical science students. The subject is intended to teach quantitative skills as well as an appreciation of the role of mathematics in biomedical science. We will describe the principles informing the design of the curriculum, such as the choice of topics to complement other biochemistry and genetics subjects in the course and based around themes such as equilibrium and stability. We will discuss the use of various interactive applets and similar technology in the course, and their effect on student learning. We will also discuss the design of assessment, including the use of oral presentations to develop and assess oral communication skills, with reference to the Threshold Learning Outcomes for Mathematical Sciences.
Undergraduate mathematics and statistics assessment practices in Australia

CRISTINA VARSAVSKY¹, KAREN HOGEBOOM¹, CARMEL COADY² AND DEBORAH KING³

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Keywords: Mathematics and statistics assessment; undergraduate; graduate attributes; threshold learning outcomes

Within the higher education sector, the current focus is on graduate outcomes and the development of threshold learning outcomes for the various disciplines, including mathematics and statistics. We ask the question, how can these outcomes be demonstrated through the assessment of units of study students undertake as part of their undergraduate program? Our study focusses on the types of assessment used across Australia, using a web search methodology to analyse information publicly available on the institutions’ websites. The findings confirm that mathematics and statistics students in Australia are still largely assessed through closed book in-semester tests and final examinations, and in-semester assignments, contributing 70% and 30% respectively to the final grade of their units of study. Our results broadly match those of a similar study done in the UK, with some differences, particularly in the percentage contribution of closed book assessment to final grade in statistical units and across year levels. Finally, implications of assessment practices for certification of student achievements are discussed.
David Boud is Professor of Adult Education in the Faculty of Arts and Social Sciences at the University of Technology Sydney. He has been involved in research and teaching development in adult, higher and professional education for many years and has contributed extensively to the literature on teaching innovation, learning from experience and student assessment. His research currently focuses on learning in workplaces. See http://www.davidboud.com

David has held the positions of Dean of the University Graduate School, Head of the School of Adult and Language Education and Associate Dean (Research and Development) in the Faculty of Education at UTS. Prior to his appointment at UTS he was Professor and Foundation Director of the Professional Development Centre at the University of New South Wales. He is a 2007 Australian Learning and Teaching Council Senior Fellow and in 2010 completed the national project associated with this: “Student assessment for learning in and after courses”. His assessment website is www.assessmentfutures.com.


Changing assessment: Shifting the emphasis to learning and use

The dominance of grading and certification is being replaced by a view that emphasises learning and how assessment should foster it and represent it. A new agenda is emerging that frames assessment not in terms of knowledge acquired (assessment of learning), but as building students’ capacity to make judgements (assessment for learning). The presentation will outline how the agenda has been changing and consider implications for how assessment is conducted in higher education.

Sponsored by
OLT project MathsAssess
Adrian Simpson is The Principal of Josephine Butler College at Durham University and reader in mathematics education. He has taught mathematics at both school and university levels and his research focuses on the transitions involved in studying mathematics at school, at the undergraduate level and at the postgraduate level. In particular, he has produced work on studying real analysis, understanding algebraic structures and comprehending proof and argumentation. He has led funded projects to enhance subject knowledge amongst those teaching A level mathematics in the UK and has written books on assessment and on mathematics education for mathematicians. Most recently he has co-directed a project looking at assessment methods used in undergraduate mathematics funded by the UK’s Higher Education Academy.

Views of mathematics assessment in the UK

This talk will outline the key findings of the Higher Education Academy funded project to explore assessment in mathematics degrees in the UK. It will outline current assessment practices and less well known alternative forms of assessment. However, it will focus on three different, but inter-related views on assessment: the view of students on how they are currently assessed, the views of staff on assessment practices and the views of students on encountering a form of assessment which was quite new to them.
The changing notion of a mathematics problem in the internet age

“If production of knowledge is understood in this way, what constitutes a ‘problem’ will depend on the nature of the humans-with-media collective. A problem that needs to be solved, or that puzzles someone, may not be a problem when a search software tool like Google is available. Similarly, a real problem for collectives of humans-with-orality may not constitute a problem for a collective of humans-with-paper-and-pencil.” (p. 804, Borba (2012))

In this talk I will unpack the above quote from a paper recently published in ZDM. I will discuss first the way internet and mobile phones in particular and digital technology in general, are changing the nature of what it means to be a human being (Castells, 2009; Borba, 2012). In order to do this, I will present the notion of production of knowledge that emphasizes the role of different technologies throughout history (Levy, 1993; Villareal, Borba, 2010). I will discuss how different media reorganize mathematical thinking (Tikhomirov, 1981, Borba and Villarreal, 2005). I will briefly discuss how different artifacts such as the blackboard are important for the development of education and how notions such as demonstrations are embedded in media such as paper-and-pencil. Examples related to the way simulation has been gaining importance – in mathematics and mathematics education - after computers became available will also be presented.

I will next discuss a perspective regarding the notion of “problem” in which problem is seen as having an objective and subjective aspect, respectively an obstacle to be overcome and an interest in overcoming such an obstacle. In
doing so, I will argue that a problem changes depending on the media that is available; in other words, I will discuss how different collectives of human-with-media (Borba and Villarreal, 2005) relate to different obstacles, and how they may become a problem or not to such a collective.

Having discussed the notions of humans-with-media and problem, I will bring this a discussion to the classroom. I will show how a simple function activity may be a problem for collectives of humans-with-paper-and-pencil, but not for a collective of humans-with-Geogebra. Could “calculate the integral of \( \frac{x^2}{(1-x^2)^{1/2}} \) or of \( \ln(x) \)” be a problem for some students in the math classroom? I will argue that this depends if Wolfram Alpha is admitted or not.

I will show these different examples showing how digital technology has evolved, how it has introduced different possibilities of problems, and how it has transformed “old problems” into mere “exercises”.

Finally I will discuss whether or not the Internet should be admitted into the classroom (Borba, 2009) and I will show how I am admitting Internet in the classroom where I teach basic notions of Calculus. I will show how video, Facebook and regular software can create different possibilities for learning in the regular classroom and in the “online classroom”. Open questions will be presented and discussion will be presented regarding whether the Internet will be admitted in the classroom, or whether the classroom will be dissolved in the Internet.

REFERENCES
Mathematics and Ocean Swimming

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Keywords: poor mathematics preparation; failure; blame.

Mathematics is often taught in first year as a service subject. It is important that mathematics academics provide a good service to those whose students they teach. The income of many mathematics groups in universities in Australia largely depends on this teaching. At times mathematics academics are seen as not succeeding in this teaching and are blamed for the lack of skills of the students taught, or blamed for not being able to pass more students.

It is claimed here that mathematicians are often given a very difficult task, that learning mathematics has some aspects of what has been called “complex learning” and that some mathematics students are involuntary learners. It is up to mathematicians to educate those whom we serve about the challenges faced and about what is realistic for their students. An analogy which might assist in this is presented.

Teaching first-year business statistics three ways

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The University of Western Australia, Australia

Keywords: Mathematics; business statistics; in-class response systems; assessment mechanisms; open book assessments

Teaching first-year service courses in mathematics and statistics is often a challenge. Such units are usually taught to large classes, most with poor mathematics backgrounds. Since these are often compulsory units, most students take them unwillingly. Attendance tends to drop off very fast and many students do not complete set work. This paper reports an innovative way to teach first-year Business Statistics that evolved over four semesters. Changes were made each semester to how the unit was delivered. Student performance is compared for the four methods, giving some perhaps surprising results. Some insight is discussed regarding the lessons learnt.
Students' mathematical preparation Part A: Lecturers’ perceptions

LINDA GALLIGAN, ANDREW WANDEL, ROBYN PIGOZZO, ANITA FREDERIKS, CLARE ROBINSON, SHAHAB ABDULLA AND TIM DALBY

University of Southern Queensland, Australia

**Keywords:** Tertiary mathematics education; mathematical under-preparedness; diversity of student population

This paper analyses first year lecturers’ perceptions of mathematics topics and skills needed in the respective courses that they teach and their perceptions of students’ preparedness for these topics. Surveys and interviews with lecturers were conducted at a regional university in Australia and showed many lecturers regarded that little mathematics was needed in their courses and that mathematics was compartmentalised into specific courses. However, when mathematics was evidenced, lecturers often perceived their students having poor skills and some have adjusted their courses accordingly.

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Preliminaries for a first year course on modelling

KERRI SPOONER

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**Keywords:** Mathematical modelling; transition secondary to tertiary

I will present the results of my 2012 research project on outcomes achieved by secondary school students who were given an authentic mathematical modelling experience. This research has impact on the potential understanding of modelling by secondary school students entering university. I will discuss what aspects of the modelling experience were possible at secondary school and therefore should be easily achievable at undergraduate level; what aspects students enjoyed about the experience and are therefore useful to include; and what aspects they struggled with, providing a sign that these things need good instruction and relevant time.
Mathematics and statistics for life science students: Discussing the contribution of mathematics and statistics departments

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Keywords: Quantitative skills; curriculum; life sciences

In the past decade, undergraduate science education, particularly the life sciences, have come under scrutiny for their lack of quantitative rigour. While some have argued that life scientists should teach quantitative skills (QS) within discipline context, recent consensus suggests that mathematicians and scientists should work together to build QS of science students. However, communication between scientists and mathematicians on matters of education has proven difficult. Building on the recent Australian Quantitative Skills in Science project, workshops aiming to facilitate communication and consensus between life scientists and mathematicians were conducted. These focused on several questions: What are the specific QS graduate learning outcomes for life sciences majors? What mathematical and statistical knowledge and skills are needed in the life sciences major? Where and how are these skills being taught across the life sciences major?

We will present data of workshop outcomes drawn from three sources: (1) participant sourced responses using standard templates provided before and during the workshops; (2) records of the workshop proceedings; and (3) documents obtained from participating institutions. This session will be informative but informal, inviting participants to engage in discussion on how mathematicians can, and should, contribute to the teaching of QS to life science students.

Students' mathematical preparation Part B: Students’ perceptions

TIM DALBY, CLARE ROBINSON, SHAHAB ABDULLA, LINDA GALLIGAN, ANITA FREDERIKS, ROBYN PIGOZZO AND ANDREW WANDEL
University of Southern Queensland, Australia

Keywords: Tertiary mathematics education; mathematical under-preparedness; diversity of student population

There is a growing concern worldwide over the decrease in the number of mathematics and science graduates. Associated with this are factors such as the mathematical under-preparedness of students entering the university system, and a lack of emphasis on the importance of mathematics for post-secondary studies. This paper analyses students’ perceived preparation in mathematics encountered in their first semester of undergraduate study at the University of Southern Queensland. The excerpts are drawn from surveys and interviews of students enrolled in first year courses that have mathematical content. The survey showed that there was a broad response of being “well prepared” for mathematics across first year courses. Interviews generally confirmed the responses to the survey in terms of students’ confidence in their mathematical preparation. However a significant number of students in the science based degrees acknowledged that they were inadequately prepared.
Leading students to creatively develop mathematical models via leaky buckets

BRYNJA KOHLER AND JAMES POWELL
Utah State University, United States

Keywords: Problem-based learning; mathematical modelling; instructional strategies

Suppose you have a bucket full of water with a hole in it, and you want to predict how long it will take for the bucket to empty. One can derive a slick first order differential equation for the height of the fluid as a function of time based on elementary physics as done by Torricelli in the 17th century – but how useful is such a model for practical purposes? In our experience this classical model is actually quite poor at capturing real data, creating ripe ground for problem-based learning. We have developed a laboratory exercise and modeling problem for undergraduate students in which they are challenged to come up with a better model than the classic. But a good problem doesn’t teach itself. We have also studied practical instructional strategies that mathematics educators have endorsed for maintaining a productive and challenging classroom atmosphere while groups of students work on cognitively demanding tasks at the elementary level. In our study, we observed that analogous instructional approaches are effective for keeping university students engaged at high levels of cognition while developing original mathematical models.

Use and perceptions of worked example videos for first-year students studying mathematics in a primary education degree

SIMON JAMES, JACQUI BROWN, TONI GILBEE AND CHLOE REES
Deakin University, Australia

Keywords: Worked example videos; primary teaching; mathematics for hearing-impaired students

Worked example videos have great potential to be useful for students when learning mathematics as they can work through the questions at their own pace, pausing as needed, but still learn from the way the demonstrator thinks and solves problems. We created worked example videos each week for a mathematics subject taught in the first year of a primary education degree and investigated student perceptions and their usage patterns. An additional aspect of this undertaking was the inclusion of subtitles to make the videos accessible to hearing impaired and ESL students. This report will reflect on the process of creating these videos, as well as some initial findings on their success.
Differential equations and handheld CAS technology

PATRICK TOBIN AND VIDA WEISS

*Australian Catholic University, Australia*

**Keywords:** Technology; differential equation; computer algebra systems

The use of handheld technology for computer algebra systems (CAS) in test and examination assessment within undergraduate mathematics courses in Australia and elsewhere has proved controversial. In this talk we present some results on the use of the CAS calculators in a service mathematics course focusing on the teaching of differential equations. We will examine some features of using the CAS and draw on experience from elsewhere. The results suggest that the time to master the tool is not a problem, though this has been flagged elsewhere as an issue. Our results also show that students don’t necessarily use the CAS to full benefit, even though they are generally positive about the learning tools. As with a CAS-free course there is still difficulty in expanding the role of conceptual learning over procedural learning. However, there are prospects for expanding students’ conceptual learning through use of multiple representations, which combined with other CAS options in learning can free up time to look at applications, formulations and the interpretation of solutions.

Immersive technology in an undergraduate mathematics course

GREG OATES, LOUISE SHERYN AND MIKE THOMAS

*The University of Auckland, New Zealand*

**Keywords:** Technology; first year courses; pedagogy

A team led by Bill Barton and Judy Paterson at The University of Auckland is investigating different approaches to the teaching and learning of undergraduate mathematics, in a project funded by Ako Aotearoa called Capturing Learning in Undergraduate Mathematics. A large part of the study centres on the development of three innovative approaches, one of which is “Intensive Student Use of Technology”. This technology component of the study is being developed by Greg Oates, Louise Sheryn and Mike Thomas, in a first-year foundation course at Auckland called Functioning in Mathematics, which essentially covers basic Calculus and Linear Algebra topics at approximately the same level as senior secondary courses. This presentation will briefly outline the immersive use of technology being trialled in this project, and the nature of the research being conducted. Some preliminary results from the pilot phase of the study will also be presented.
Assignment submission via video in a large first year calculus class

DAVID HOLGATE, JUSTIN MUNYAKAZI, LEILA ADAMS AND DUNCAN SMITH
University of the Western Cape, South Africa

**Keywords:** Technology; mobile phone; video; assessment; group work

A face to face explanation of the solution to a mathematics problem demonstrates understanding far more than a written report. This assertion was the core motivation behind us asking our first-year calculus students to submit one of their weekly assignments by video.

Students in our course work in groups of five throughout the year and submit weekly assignments, usually as a group. These assignments form part of the ongoing assessment for the course. There are a number of difficulties in evaluating group submissions. Obvious concerns include judging who contributed to the solution, how much was copied and which group members understood. More subtly, such written submissions cannot always expose where misunderstanding occurs nor reflect the degree of group engagement.

In this talk we will report on the success of requiring groups to submit a mobile phone recorded video of them explaining the weekly assignment. This was exploratory on our part and proved to be more successful than we anticipated! Student engagement was very high and we were certainly able to examine the assignment with deeper insight. The intention is to include such assignments in our course more regularly next year.

First year university students’ understanding of functions: Over a decade after the introduction of CAS in Australian high schools, what is new?

CAROLINE BARDINI, ROBYN PIERCE AND JILL VINCENT
The University of Melbourne, Australia

**Keywords:** Algebra; functions; university mathematics; CAS

A strong understanding of the concept of function is vital for students studying calculus and has been seen as a unifying concept in mathematics and between mathematics and the real world. This paper reports on a pilot research study on first year university students’ understanding of functions. Special attention has been given to students’ background on the usage of technology at secondary school to look for potential impact on students’ understanding of concepts. Results collected halfway through the project are analysed and implications for university teachers are discussed.
WeBWorK CLASS: Fostering design experiment research on concept development

GULDEN KARAKOK\textsuperscript{1}, NICOLE ENGELKE\textsuperscript{2} AND AARON WANGBERG\textsuperscript{3}

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\textbf{Keywords:} Calculus; design experiment; online assignment; WeBWorK

We introduce the WeBWorK Collaborative Learning and Active Support System (CLASS), an extension to the popular online homework system, WeBWorK, available for any touch-enabled device. WeBWorK CLASS is a powerful tool for use in and out of the classroom which engages students, aids instructors, and allows researchers to explore student thinking. Research enhancements allow us to analyze both quantitative and qualitative data from in-class sessions, online homework, and other assessments. We use the system in a first semester calculus class for ongoing iterations of a design experiment focusing on function composition as it relates to calculus concepts such as the chain rule. Examples from collected data demonstrate the utility of CLASS as a research tool. Further, we describe how an approach to calculus based on differentials was used to teach the chain rule and how students interpret it.

Film: developing a new resource for teaching undergraduate biometry

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\textbf{Keywords:} Film; biometry; experimental design; video; visualisation

A 15 min pilot video made by the speaker became a valuable teaching tool in a large biometry course (STAT2701) in the School of Agriculture and Food Science at the University of Queensland.

This video was motivated by the need to bring the relevance of experimental design and analysis into a large class of undergraduates who had little experience of research or experimentation. It aimed to bring the field, glasshouse and paddock into the lecture theatre.

The video covered biological variation as the background to biometry and its important use in experimental design. A script was developed for the filming of experiments in the research fields and glasshouses. Researchers and graduate students assisted in production.

Students appreciated the value of biometry as a relevant tool to assist them in meaningful scientific research. The final cut incorporated student and tutor feedback.

The success of this has led to another project in 2013 involving students participating in the visualisation of concepts in biometry and two more films under production.
Using Moodle for assessments of large groups: Mathematics students’ experiences

PRAGASHNI PADAYACHEE
Nelson Mandela Metropolitan University, South Africa

Keywords: Online assessment; Moodle; blended learning; mathematics students

With the rapid growth in higher education in South Africa, student numbers have grown considerably in many undergraduate courses. Teaching large groups seems to have become the norm at many higher education institutions. Assessments of these large groups is one of the biggest challenges facing educators. To enhance student learning consideration should be given to efficient assessment and effective feedback of these assessments. In response many are considering online assessment.

This action research study describes the experiences of a group of 469 students taking the mathematics for accounting course and taking their assessments via Moodle at the Nelson Mandela Metropolitan University in the Eastern Cape of South Africa.

Preliminary analysis of the data revealed that students maintained that Moodle provided a supportive learning environment in which to learn mathematics. Students indicated that assessments were more effective and efficient, providing immediate feedback and that this approach to assessment impacted favourably on their mathematics learning.

Knowledge gained from this study may contribute to an improvement of the assessment practices of the mathematics for accounting course by presenting its pitfalls and successes.

Aiding conceptualisation in first-year statistics with interactive applets

ANTHONY MORPHETT
University of Melbourne, Australia

Keywords: Statistics; applets; Mathematica

Visualisation is an important part of conceptualisation, and interactive computer applets are a medium well-suited for aiding visualisation of statistical concepts. Interactive applets have been used for this purpose in statistics education for many years, however there are still important statistical concepts for which no suitable interactive resources exist. We will report on a series of online interactive demonstration applets currently being developed which explore fundamental concepts of statistics in ways that existing resources do not. The applets are written largely in Mathematica and freely accessible in a browser via the Wolfram Demonstrations Project. We will discuss the pedagogical and technical principles informing the design of the applets and their implementation in first-year statistics classes, and discuss our experiences with Mathematica as a platform for such resources.
Audience insights: Feed forward in professional development

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The University of Auckland, New Zealand

Keywords: Professional development; variation; perturbation; reflection; enactment

As a result of watching a colleague teach, Tanya decided to make changes to her lecturing practice which resulted in very positive changes to students’ evaluations of her lecturing. We describe the model of intra-departmental professional development in which she had the opportunity both to observe others teach and examine and discuss her own practice. The variation between a colleague’s lecture practice, her previous experience of lecturing practice, and her own practice perturbed her and provided the initial impetus for her decision. We call this a feed-forward mechanism.

Practice to academy transitions

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Keywords: Professional development; mathematics; statistics; faculty

Macquarie Lighthouse was the first marine lighthouse built in Australia. Following the arrival of the First Fleet in 1788, the Macquarie flagstaff was erected to signal the approach of supply ships destined for Sydney Cove. Through the fog of an aging workforce, increased casualisation, student diversity and changes to modes, methods and media in teaching and learning, universities have been compelled to look elsewhere to recruit a substantial portion of their academic staff. In short, the demand for academics and academic capability is far exceeding supply. The sirens call radiating from universities promises new recruits greater work/life balance, increased flexibility and intellectual prestige. While affecting all disciplines, these broader sectoral trends directly affect the capacity of universities to provide quality teaching and learning; in particular, for undergraduate mathematics and statistics education. For many industry-practitioners, the above reasons are sufficient to compel them to ‘make the move’ from industry to academia. However, the everyday realities of life in higher education institutions come with a series of significant and unexpected challenges. Drawing on qualitative interview data with transitioned ‘pracademics’, this presentation explores the teaching and learning implications of these transitions and the personal/professional challenges experienced by these individuals.
Teaching foundations of finite group theory via programming

ILYA SHILIN
Sholokhov Moscow State University for the Humanities, and Moscow Aviation Institute, Russia

Keywords: Finite group; programming problems

This presentation contains some programming problems which can be suggested for first-year mathematics students starting to learn foundations of group theory. These problems are related to important notions such as subgroup, coset, normal divisor, symmetric group, normalizer, centralizer, homomorphism, and automorphism. To translate a problem with mathematical language to a program, students should thoroughly understand the essence of the problem, by considering the problem in detail. When translating the results obtained on the computer back into mathematical language, the same happens. Thus, the using of programming contributes to a successful, non-formal learning theory and promotes programming skills. The above problems are suggested for students of the Faculty of Science at Sholokhov Moscow State University for the Humanities. More details of our approach are available in I. A. Shilin, Some Programming Problems for Learning Foundations of Group Theory, Int J Math Educ Sci Technol, DOI:10.1080/0020739X.2013.837523.

Perceptions of feedback in mathematics – results from a preliminary investigation at three Australian universities

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Keywords: feedback; student perception; undergraduate

Feedback on learning is recognised as so important that it features on student evaluation of teaching surveys and on Australia’s national Course Experience Questionnaire. Ideally, the student responses are then used to improve on practices. However, we argue that this process is flawed in first year mathematics. In this pilot study, we surveyed students enrolled in first year mathematics subjects at three Australian universities about their perceptions of feedback. Students were asked what they considered to be feedback in mathematics and what feedback they had received in their mathematics subject. In this study we compare these answers to the lecturers’ views of what types of feedback were provided. We come to the conclusion that students enrolled in first year mathematics subjects perceive feedback very differently to their lecturers. This devalues the usefulness of questions about feedback on end-of-semester surveys on the quality of teaching. We also question whether students may be missing out on accessing feedback that is intentionally provided to improve their learning.

Efficacy and efficiency in formative assessment: an informed reflection on the value of partial marking

KATHERINE A. SEATON

Abstract published in IJMEST journal.
Mathematical knowledge of the lecturer and mathematical knowledge for lecturing at the undergraduate level: An attempt to distinguish between the two

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University of Auckland, New Zealand

**Keywords:** Mathematical knowledge; mathematical knowledge of teacher; mathematical knowledge for teaching

This paper is an attempt to distinguish between mathematical knowledge possessed by a lecturer and mathematical knowledge that is used for lecturing. For that, existing theoretical models on mathematical knowledge for primary and secondary teaching were examined. The key idea is the understanding that lecturing contexts mostly reveal mathematical knowledge used for lecturing, but not the entirety of mathematical knowledge possessed by the lecturer. This broadens the notion of mathematical knowledge for lecturing (MKfLg) by embedding it in the mathematical knowledge of lecturer (MKoLr). Acknowledging the difficulty in predicting exact boundaries between these two mathematical knowledge bases, working definitions are constructed. A major research question that may arise on the acceptance of these definitions is what particular component of MKoLr is the main contributor to MKfLg. To this end, my research is to develop a theoretical model of mathematical knowledge required for lecturing at the tertiary level, based on models constructed for secondary teaching. The model will be adapted to include research knowledge and other tertiary factors. Of particular interest will be the unique and personal knowledge lecturers gain from their own research work.

Mathematics exams as a learning process to build skills, knowledge and confidence

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**Keywords:** Mathematics confidence; feedback; mastery exams; pre-service teachers

This paper focuses on the challenges of inspiring mathematics learning in pre-service primary teachers and the subsequent modifications made to a pair of mathematics content subjects to address these issues. Many of the student cohort have poor basic mathematical skills, little confidence in their mathematical ability and as a result often exhibit avoidance behaviour, yet need an in-depth understanding of certain mathematical concepts to be successful in their chosen career. To motivate learning, modifications were made to the implementation of the subjects which include the introduction of mastery exams into the assessment and additional face-to-face class time providing support for those students deemed to be at risk. We present our particular context, a review of the literature and details of our mastery exam system. We reflect on the implementation of this system, the outcomes in student performance, and student reaction towards the assessment structure.
An elementary statistical workshop course for postgraduate research students

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Keywords: Statistics support; workshops; postgraduate; graduate; statistical confidence

Postgraduate students from Arts, Humanities and Social Science subjects increasingly need a firm grounding in school- and college-level statistics. This need is only partially met by departmental research methods courses, and Mathematics and Statistics Support Centres are increasingly relied upon to provide additional statistics support for postgraduate students. This presentation reports on a workshop series designed to introduce students to the topics of descriptive statistics, graphs, hypothesis testing, and the computer package SPSS. It provides evidence that the workshops met their aims and that they were popular both in terms of student attendance and feedback. It demonstrates that such a workshop series may (a) attract attendees from a wider variety of departments than might be expected, (b) be of interest for both lectured Masters and research PhD students and (c) that it can be a good way of increasing knowledge of other forms of support available from Mathematics and Statistics Support Centres.

Introducing queuing theory through simulations

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Keywords: queuing theory; modelling; simulations

Queuing theory is usually introduced to students from second year onwards in a university undergraduate programme, as the mathematical principles governing queues can be fairly demanding, making it challenging to introduce any earlier. However, we often see queues and experience queuing in real life. It would therefore be appropriate, relevant and useful to introduce the concept of queuing theory to pre-university students or first-year undergraduates. The approach suggested is through simulation models supported by suitable technology. In doing so, students can understand some basic probability theory and statistical concepts, such as the Poisson process and exponential distribution, and learn how queues may be modelled through simulation, without the need to know all about classical queuing theory. In this paper, we will discuss the role that simulation can play in a classroom to create real world learning experiences for students. To provide a concrete illustration, a set of real data collected in an ATM queue will be used to explain how students can systematically be engaged in a modelling activity involving queues.
Merrilyn Goos is a Professor of Education at The University of Queensland, Australia, where she has worked for 20 years as a mathematics teacher educator and mathematics education researcher. From 2008-2012 she was Director of the Teaching and Educational Development Institute, working with all Faculties and disciplines to improve the quality of teaching and learning in the university. Her research interests include mathematics teacher education, numeracy education in school and non-school contexts, and teaching and learning in higher education. She is currently President of the Mathematics Education Research Group of Australia and an Associate Editor of Educational Studies in Mathematics.

Knowledge for teaching secondary school mathematics: What counts?

Abstract published in IJMEST.

Sponsored by AMSLaTNeT
StatsCasts: supporting student learning of introductory statistics

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Keywords: Statistics education; learning support; screencast

With the diversity in the backgrounds of students currently entering universities, many students lack the preparedness to undertake studies that include quantitative content. At the same time, many of these students are required to enrol in an introductory statistics course at some stage during their undergraduate program of study. This, along with an associated prevalence of statistics anxiety, means that many students require additional assistance to progress and stay engaged. A variety of support mechanisms may need to be enacted to assist students to succeed. This paper introduces and discusses the development of StatsCasts: short, focused screencasts on topics students have struggled with in the past, for anywhere, anytime support in learning statistical concepts. An evaluation of the pilot stage of a larger research project is presented, to show how students at one of the three collaborating universities perceive these multi-media support resources, and to what level students access them. Initial findings indicate that most students found the StatsCasts beneficial to their learning and understanding of the relevant concepts.

Issues and trends: a review of Delta conference papers from 1997 to 2011

JENNY HENDERSON AND SANDRA BRITTON

The University of Sydney, Australia

Keywords: Tertiary mathematics education; review of research; issues; trends

From the first Delta conference in 1997 to the eighth in 2011, a total of 409 papers have been published in special issues of journals or in conference proceedings. These papers cover a wide variety of topics in the teaching and learning of tertiary mathematics and statistics, largely within universities in southern hemisphere countries. This article reviews and classifies past papers, reflects on apparent trends and attempts to identify ideas for future research projects and initiatives in teaching and learning that are suggested by past Delta papers.

Mathematics education in Mexico: Theoretical contributions for teaching and learning in higher education

JUAN CARLOS PONCE-CAMPUZANO

Abstract published in IJMEST journal.
Interactive teaching using tablet PCs: Designing effective questions

DAPHNE ROBSON AND DAVE KENNEDY
Christchurch Polytechnic Institute of Technology, New Zealand

Keywords: Tablets, tablet PCs, questions, interactive, mathematics, learning

Clickers have been shown to help students learn concepts when used with carefully written multi-choice questions. Tablet PCs can be used in a similar way with the advantage that students can also submit their working and strategies. But what types of questions are best suited to this interactive use of tablet PCs? In this preliminary study, students’ perceptions of a range of types of questions were analysed. Students in a course in discrete mathematics and statistics reported that most questions were useful for learning. This result is important as it is much easier for teachers to write questions for tablet PCs by formatting existing questions than to write meaningful multi-choice questions for clickers. Questions benefitted from a structured layout such as a table or gaps to be filled. Students also reported that questions that encouraged in-depth thinking and discussion, such as open questions, common misconceptions, or choosing a best strategy were particularly useful for their learning.

Addressing dualism in mathematical abstraction: An argument for the role of Construal Level Theory in mathematics education

STUART TORR AND TRACY S. CRAIG
University of Cape Town, South Africa

Keywords: Construal level theory; priming; metacognition; procedural; conceptual; heuristic strategies; classroom communication

Learners of mathematics often struggle to balance the apparently conflicting demands for abstract thinking as well as (often simultaneous) concrete cognitive engagement. Conflicting demands of successful mathematical engagement have been addressed in the literature pertaining to procedural versus conceptual approaches to mathematical learning as well as in the literature on cognitive and meta-cognitive mathematical demands. Construal Level Theory offers an opportunity to understand both these dualities as aspects of the same psychological response to contextual priming. In addition, Construal Level Theory can be understood to illuminate student difficulties with heuristic strategies in mathematical problem-solving. The focus of Construal Level Theory on abstract and concrete cognitive construals as a consequence of psychological distance provides a useful lens for teaching and learning opportunities. We argue that Construal Level Theory offers an opportunity to draw together several strands of mathematics education theory and to help educators address learning challenges in the classroom.
Attitudes of pre-service primary teachers to mathematics

DILSHARA HILL AND CAROLYN KENNETT

*Macquarie University, Australia*

**Keywords:** Mathematics; attitudes; pre-service primary teachers

In this presentation we look at the attitudes that pre-service primary teachers have towards mathematics, and in particular we look at the cohort of these students at Macquarie University. Our study involved surveying students regarding their mathematical background and their attitudes to mathematics. This presentation looks at the results, which were analysed using both a quantitative and qualitative approach. We will be focusing on the areas that affect attitude such as maths anxiety and students’ mathematical background, together with discussing our own reflections about teaching mathematics.

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Using a classroom response system to transform student engagement

JEFF WALDOCK

*Sheffield Hallam University, United Kingdom*

**Keywords:** In-class response system; student engagement; formative assessment; team work

Student engagement with course material can be variable. Lectures are often didactic and in group tutorials it is often difficult to get everyone to make productive use of the time.

In-class response systems promote cooperative learning with "students becoming active participants in their learning" (Beatty, 2006). 'Socrative' allows any web-enabled device to respond to either ad-hoc or prepared tests, and has been used weekly with one final year group in 2012. This introduced team-work and an element of competition and engagement improved dramatically. Each session also included group discussion evaluating what had been learned and how 'Socrative' had helped, informing the delivery of the following class and involving students closely in the module design and delivery.

'Socrative' has also been used in lectures with a first year group to provoke discussion and for formative assessment. In this session I will demonstrate the system, giving examples of its use in a classroom setting, and discuss its effective use.

If you plan to attend, and own a smartphone or tablet device, please download and install the free 'Socrative Student' app first.

A constructivist approach to mathematics laboratory classes

RAYMOND SUMMIT AND TONY RICKARDS
Curtin University, Australia

Keywords: constructivism; conceptual understanding; dynamic visualisation; animation; mathematics computer laboratory; flipped classroom

This article discusses a framework for mathematics education that includes higher-order levels of learning. Theories of learning are also examined, with constructivism discussed in more detail. The constructivist philosophy is applied to structuring a computer-laboratory program in mathematics that differs from the traditional structure where the development of skills in a computer algebra system is a major objective. A structure is proposed of guided mathematical investigations, which makes use of dynamic visualisation, with the aim of helping students construct their own knowledge and develop conceptual understanding.

Future state of the evolving classroom in mathematics

BATHI KASTURIARACHI
Kent State University at Stark, United States

Keywords: Blended courses; cooperative learning; experiential learner

The renewal movement in undergraduate mathematics in the United States has roots that trace back to the 1986 Tulane Conference that outlined a vision for change in calculus along with suggestions for implementation. The movement, with its bold and innovative approaches focused on student-centered learning, was able to uncover the richness in undergraduate mathematics by supporting reform that was curriculum driven at the bow and technologically backed at the stern. As we approach the three decade mark of the renewal movement we see a rapid evolution that is occurring, which without proper streamlining, could have a profound impact on all of undergraduate mathematics education. Outstanding pedagogical practices take into account the environment in which learning occurs as well as the background of the student body, making the finest practices, institution dependent. This presentation reports on three models of delivery that are currently being used and have worked successfully to varying degrees. We will emphasize one of these – the blended model, and explain how it could be used to motivate students to excel in mathematics. Details of these pedagogical practices, as well as appropriate evidence of success, are presented.
Effectiveness of online lectures in a first year mathematics unit

CAROLYN KENNETT AND DILSHARA HILL

Macquarie University, Australia

Keywords: Online lectures; mathematics; first year students

There has been a considerable amount of literature examining the student response to online lectures in mathematics. Fewer papers, however, consider the effectiveness of online lectures as a vehicle for enhancing student success in mathematics. In this presentation we examine the results of a study done to determine the effectiveness on online lectures in a first year mathematics unit. The study involved surveying the students regarding their use of the online lecture material and an analysis of the results of different cohorts of students. Our sample included students who only accessed the lectures online as well as a cohort who attended both the "live" lectures and used the online material as necessary. Using the results of this study, student feedback, and our own reflections we will discuss some conclusions that can be drawn from this investigation.

Students rating of teacher practices

G. HARRIS, T. STEVENS, X. LIUA AND SZ. AGUIRRE-MUNOZ

Abstract published in IJMEST journal.

The presence of mathematics anxiety in future primary school teachers and factors affecting abatement

SIMON JAMES, LYNN BATTEN AND MICHELLE CYGANOWSKI

Deakin University, Australia

Keywords: Mathematics anxiety; whole teacher approach; primary teaching

This study reflects on the implementation of various teaching initiatives for reducing anxiety toward mathematics in students studying to become primary school teachers. We highlight similarities between these practices and those promoted by the ‘Whole Teacher’ approach – in particular, the aim to develop attitudes along with knowledge and skills. Here, the negative past associations with mathematics and anxiety toward mathematics that students bring with them have been a key consideration when designing the subject content and delivery. Given the important role these students will have in shaping mathematics education in the future, we suggest frameworks such as that of the ‘Whole Teacher’ could be extended to the university setting. We investigate four years of student feedback pertaining to a first year undergraduate mathematics unit, contending that the teaching initiatives introduced over time have helped students develop a positive attitude toward mathematics. We note, however, that the student-teacher relationship was still the most prominent factor directly identified by students who previously had a fear or negative attitude toward mathematics.
Abstracts for Poster Presentations
Teaching and learning differential equations with graphical, numerical and analytical approaches

MARIA MADALENA DULLIUS
Centro Universitário Univates, Brazil

Keywords: Teaching and learning; differential equations; computational resources; graphic numerical and analytical approach

The work we present was carried out to improve the differential equations teaching-learning process and explore the potential of computers to provide favourable conditions for meaningful learning. The research involves the development of a pedagogical practice with students of Engineering and Industrial Chemistry courses. The practice teaching proposals are focused on problem solving in situations with the use of computer which initially explore the equation solutions obtained using software and later use analytical techniques. The methodology of classes follows assumptions from the Vygotsky’s Theory and the instructional materials are based on Ausubel’s Meaningful Learning Theory. We used specially designed tools for information collection about the students’ learning during the lessons: a questionnaire, interviews, guides to activities, initial and final knowledge tests and field notes. Our results indicate that the use of computational resources can be an important tool in the differential equations teaching-learning process. However, it is also important to emphasize that when we offer a differentiated approach we often create discomfort and dissatisfaction among the students, and despite working with numeric and graphic analytical approaches the students still prioritize the analytical techniques.

Can instructors accurately describe their classroom practice?
Assessing the impact of professional development on inquiry-based learning and teaching in undergraduate mathematics

SANDRA LAURSEN AND CHARLES HAYWARD
University of Colorado Boulder, United States

Keywords: Inquiry-based learning; professional development; evaluation

Professional development (PD) is an important tool for changing instructional practice in higher education. Yet in order to design and deliver effective PD programs, we must be able to measure the instructional changes that instructors do or do not put into practice in response to PD. We will present findings on the outcomes of multi-day workshops on inquiry-based learning (IBL) in college mathematics that offer insight on instructors’ teaching practices and beliefs and how these may evolve in response to PD experiences.

Participating instructors had strong pre-existing beliefs in the value of inquiry, but their initial classroom practices emphasized lecture and solving examples. Pre/post surveys for 3 cohorts show that, during the workshop, faculty made strong gains in IBL knowledge and moderate gains in IBL skills. Their beliefs in IBL’s effectiveness and motivation to use it—already strong—became even stronger. Follow-up results for the first cohort suggest that over 50% of respondents have made significant shifts toward greater use of student-centered teaching in the year following the workshop. Moreover, the evaluation instruments appear to be sensitive to differences in emphasis from workshop to workshop. Ongoing work will seek to validate items that self-report instructional practice against classroom observation.
'Who put the maths in chemistry?' Raising student awareness and self-efficacy in mathematical process skills in first-year chemistry

ARTI SINGH, GWEN LAWRIE AND MICHAEL JENNINGS
The University of Queensland, Australia

**Keywords:** Quantitative skills; confidence; self-regulation; chemistry

The diversity of backgrounds, abilities and aspirations of students in large-enrolment first-year chemistry courses presents a challenge to instructors who aim to identify the nature of the remedial support necessary to underpin assumed mathematical skills. Many students enrol in chemistry without intermediate level senior secondary mathematics despite it being a prerequisite. Several of the basic skills that appear to be missing derive from even earlier in their high school experience including proportional reasoning and unit conversions. A separate but well known issue is that students, who may be very competent in basic mathematical process skills, struggle to recognise a mathematical relationship underlying a specific problem framed in a chemistry context (Finlayson, 2013). A diagnostic test delivered in 2012 to a large first-year chemistry cohort revealed that while many students had competence in senior high school mathematics, they possessed low confidence in their ability to apply their existing knowledge to chemistry problems. Supporting resources were released to the students through the online course learning management system (Blackboard) to encourage self-regulated study, this enabled application of analytics to students’ access. A post-test (N = 806) and subsequent focus groups explored students' self-awareness of their own mathematical skills and their relation to chemistry problem-solving.
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